

LIFE HISTORY AND ECOLOGY OF
BAETISCA BAJKOVI NEAVE, IN
BEECH FORK OF TWELVEPOLE CREEK,
WAYNE COUNTY, WEST VIRGINIA
(EPHEMEROPTERA: BAETISCIDAE)¹

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The primary objective of this study was to investigate the life history and ecology of the mayfly *Baetisca bajkovi* Neave in Beech Fork of Twelvepole Creek, Wayne County, West Virginia. Several investigators, including Traver (1931), McDunnough (1932), Berner (1940, 1955), Edmunds (1960), Schneider and Berner (1963), Lehmkuhl (1972), Pescador and Peters (1971, 1974), Morris (1976), and Tarter and Kirchner (1978), have reported taxonomical and ecological information on the genus *Baetisca* in North America.

TAXONOMY AND DISTRIBUTION

The family Baetiscidae is endemic in North America and contains only the genus *Baetisca*. The genus was established by Walsh (1862). Neave (1934) and Daggy (1945) described the nymph and imago, respectively, of *B. bajkovi*. The Nearctic distribution of *B. bajkovi* includes Alberta, Manitoba, and Saskatchewan in Canada (Neave, 1934 and Lehmkuhl, 1972), and Illinois, Indiana, Minnesota (Burks, 1953), Wisconsin (Hilsenhoff, 1970), and West Virginia in the United States. Chaffee (1978) recorded it from 17 counties in West Virginia.

The *B. bajkovi* nymphs were found mostly in a stream substrate that was predominantly small stones and sand, and with leaf litter or other plant material present. They were found only in the riffles, and were most frequently collected from water 10 to 26 cm in depth.

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MATERIALS AND METHODS

Beech Fork in Wayne County, West Virginia, is the study area. It is 45.9 km long and drains moderate to steep slopes of mesophytic hardwood forest. It originates at an elevation of approximately 343 m and flows northwesterly to enter Twelvepole Creek at an elevation of 165 m near Lavalette, West Virginia. The average gradient is 3.9 m/km. The study site is located at 38° 18' 57" N latitude and 82° 25' 22" W longitude, and is 3.7 km above the mouth of Beech Fork. It is a slow to medium speed riffle 55 m long that averages 5.2 m in width and 25.4 cm in depth. The substrate consists of large rocks and stones, and a mixture of gravel, sand, and silt. The more dominant species of the riparian forest are Boxelder *Acer negundo* L., Silver Maple *A. saccharinum* L., Black Walnut *Juglans nigra* L., Sycamore *Platanus occidentalis* L., and Slippery Elm *Ulmus rubra* Muhl.

Monthly sampling for *Baetisca bajkovi* nymphs began in June 1976 and continued through May 1977. Sampling was accomplished by starting at the lower end of the riffle and working upstream using a long handled bottom dredge with a fine mesh net (60 threads per inch). The dredge was raked along the bottom while the substrate was disturbed and loosened upstream allowing the organisms to drift into the net. The nymphs were immediately preserved in 70 percent ethanol.

Water temperature was measured each month with a mercury thermometer. The thermometer was placed in the riffle at a depth of approximately 5 cm. Determinations of dissolved oxygen concentration, bicarbonate alkalinity, and total hardness were carried out with a Hach chemical kit, Model AL-36-WR. The pH was measured with a Corning Model 5 pH meter. The oxygen saturation values were obtained using Rawson's nomogram (Welch, 1948).

Length-frequency distributions were recorded for the nymphs to help determine the duration of the life cycle. Histograms were arranged in 1 mm size groups for each month with the males and females combined. The body length of the nymphs, from the anterior-most tip of the head to the base of the caudal filaments, was measured with a dial Vernier caliper under a dissecting microscope to the nearest 0.1 mm. Head width measurements were used to show the monthly index of growth. The head widths (including eyes) were measured to the nearest 0.01 mm with an ocular micrometer in a Bausch and Lomb dissecting microscope. A population range dia-

gram was used to show the monthly variation in head widths (Hubbs and Perlmutter, 1942). The growth rate of the nymphs (sexes combined) was determined by using the mean monthly head width measurements.

Relative abundance of foregut contents of the nymphs was determined for each month. Five nymphs were selected at random from each month's sample for analysis. Micro-dissecting scissors were used to sever the head and make an incision along the midline of the ventral surface. The foregut was then severed from the intestine and excised. The foregut contents were extruded onto a glass slide and examined under a microscope with a Whipple ocular grid at 430 \times magnification. Five grids or fields were randomly selected to be examined for each nymph. The percentage of composition for each food item was determined by figuring the percentage of small grid squares within each field that contained each of the different food items. Percentage composition was determined for the following food items: (1) plant detritus, (2) diatoms, (3) filamentous algae, and (4) mineral particles.

The sex of the nymphs was determined by the size and shape of the eyes. The eyes of the male are much larger and positioned more closely together than those of the female. The chi-square test was applied to the nymphs to determine any significant departure from the 1:1 ratio at the 0.05 confidence level.

The last instar nymphs collected in April and May were returned to the laboratory for rearing. They were observed closely, and the dates and times of emergence for both the subimagos and imagos were recorded.

The fecundity of *B. bajkovi* was determined by direct egg counts of the adult females using a Bausch and Lomb dissecting microscope. Using micro-dissecting scissors the body cavity was carefully opened with a long dorsal incision. Both ovaries were then carefully excised and the eggs extruded into a culture dish for counting. Size measurements were made on 25 eggs from each female with an ocular micrometer in a dissecting microscope to the nearest 0.01 mm. The external morphology of the eggs was also viewed under a microscope at 100 \times magnification.

RESULTS AND DISCUSSION

Stream Environment. The mean annual water temperature in Beech Fork during the study period was 13.5 C. The monthly ex-

tremes ranged from 3.3 to 23.3 C in January and July respectively. The mean hydrogen ion concentration (pH) was 7.1 with a range of 6.7 to 7.5 in August and December respectively. The mean dissolved oxygen concentration was 8.9 mg/l and ranged from 6.3 to 11.0 mg/l, August and January respectively. The oxygen saturation mean was 83.8 percent and ranged from 73.0 percent in August to 95.0 percent in April. The mean bicarbonate alkalinity concentration was 47.5 mg/l with a range of 30.0 to 65.0 mg/l, February and September respectively. The mean total hardness was 59.6 mg/l with a range of 50.0 to 70.0 mg/l, January and October respectively.

Nymphal Length-Frequencies. Length-frequency histograms of the *B. bajkovi* nymphs are shown in Figure 1. The smallest and earliest nymph was collected in July 1976 and measured 0.76 mm in length. The largest nymph, a female with a length of 10.4 mm, was collected in May 1977. The monthly length distributions, the absence of nymphs in June, and the total absence of mature nymphs in the late summer, fall, and winter months indicates a one year (univoltine) life cycle. Similar findings on the life cycle from other studies in the genus *Baetisca* have been reported by Traver (1931), Berner (1955), Pescador and Peters (1971, 1974), and Lehmkuhl (1972).

Nymphal Growth. Head width measurements of *B. bajkovi* nymphs showing the monthly progression of growth are illustrated with a population range diagram (Figure 2.) Head widths ranged from the smallest nymph in July (0.31 mm) to the largest male (2.67 mm) and the largest female (2.81 mm) in May. Figure 2 also illustrates the univoltine life cycle and shows a definite female size superiority.

The greatest growth rate exhibited at any time during the life cycle was 80.0 percent which occurred from July to August when the mean monthly head width increased from 0.45 to 0.81 mm. The lowest growth rate (1.3%) occurred from April to May when the mean monthly head width increased from 2.32 to 2.35 mm. Nymphal growth rate was also very low (3.5%) from January to February when the lowest water temperatures (3.3 and 4.4 C) were recorded for the study.

Nymphal Food Habits. The relative abundance of foregut contents of *B. bajkovi* is given in Table 1. The nymphs are detritivorous with almost two-thirds (65.3%) of the diet composed of plant and leaf detritus. Diatoms were the next most abundant item (17.1%) in

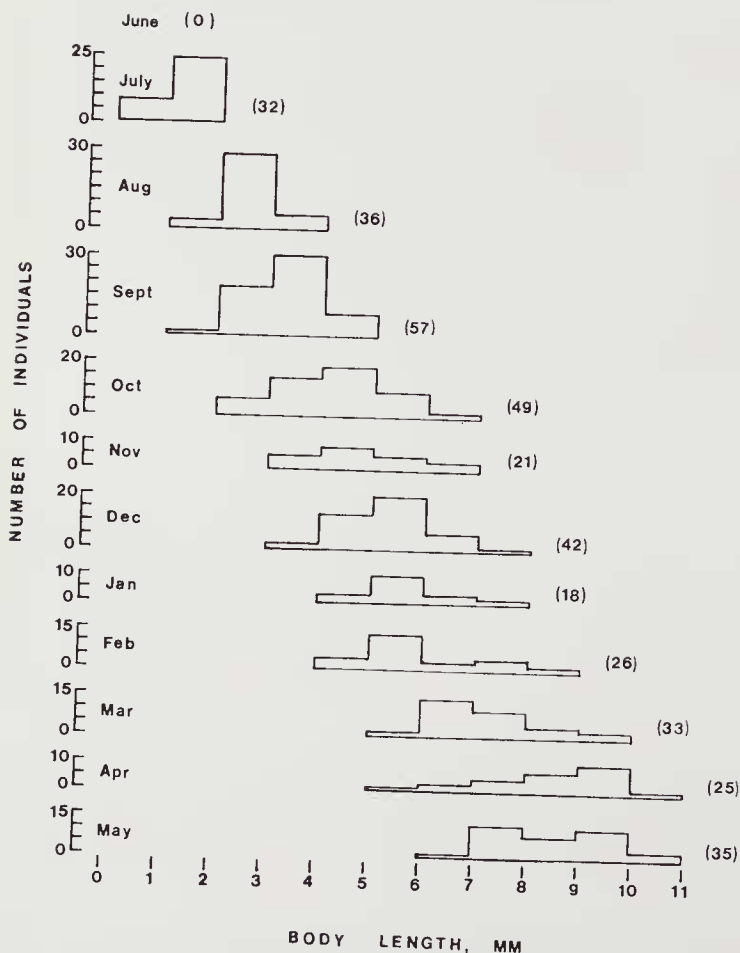


Figure 1. Length-frequency histograms showing monthly distributions of *B. bajkovi* nymphs, Beech Fork of Twelvepole Creek, Wayne County, West Virginia, 1976-77. Number of individuals collected each month is given in parentheses.

the diet. The diatoms most numerous in the foreguts, and in monthly occurrence, were *Navicula* spp., *Cymbella* sp., *Diatoma* sp., and *Synedra* sp. *Navicula* was the only diatom present in the foregut contents every month. The recognizable filamentous algae found in small amounts were *Cladophora* sp., *Spirogyra* sp., and *Ulothrix* sp. Mineral particles were always plentiful, but it is not



Figure 2. Population range diagram showing monthly head width variations in *B. bajkovi* nymphs, Beech Fork of Twelvepole Creek, Wayne County, West Virginia, 1976-77. Vertical lines = range, horizontal lines = mean, open rectangles = one standard deviation, dark rectangles = two standard errors of the mean, numbers = sample size, f = females, m = males.

known to what extent they may be a part of the regular diet or ingested accidentally along with other food items. The most noticeable monthly variations in diet composition were the increase in plant detritus during the fall months, probably due to the large amount of leaves in the stream, and the increase in the abundance of diatoms in the spring months.

Nymphs of other mayfly species feeding on plant detritus, diatoms, and algae have been reported by Minshall (1967), Pescador and Peters (1974), Richardson and Tarter (1976), and Hamilton and Tarter (1977).

Nymphal Sex Ratio. The chi-square test on *B. bajkovi* nymphs showed no significant departure from the 1:1 sex ratio at the 0.05 confidence level. The test was applied to 163 males and 179 females collected from August through May. The July nymphs were too small to sex.

Adult Stage. Last instar *B. bajkovi* nymphs with wing pads developing were first collected from the stream April 26, and the last

nymph, a female, was collected May 17. They were reared in the laboratory, and the adults emerged from May 2 to May 26. All subimagos emerged between 9:00 AM and 7:00 PM with the imagos emerging 13 to 25 hours later.

Emergence data for other species of the genus *Baetisca* have been reported by other authors. Traver (1931) observed subimagos of *B. carolina* emerging between 8:00 AM and 5:30 PM with the imagos emerging 21 to 30 hours later. Berner (1955) observed subimago emergence of *B. escambiensis* between 9:30 AM and 1:30 PM and found the imagos emerging 40 to 44 hours later. Pescador and Peters (1974), in studying *B. rogersi*, observed subimagos emerging from the stream between 8:30 AM and 2:30 PM, while the laboratory subimagos emerged between 10:00 AM and 8:30 PM. The imagos emerged 12 to 30 hours later.

Ovarian egg counts of 10 adult *B. bajkovi* females ranged from 1508 to 3158 eggs per individual; the mean was 2361. Pescador and Peters (1974) reported that the egg counts for *B. rogersi* ranged from 1500 to 2727 per individual, with the mean being 2168.

The eggs of *B. bajkovi* are subspherical, and the average measurements were 0.15×0.19 mm. The eggs are greenish in color with an

Table 1. Relative abundance of foregut contents of *Baetisca bajkovi* nymphs, Beech Fork of Twelvepole Creek, Wayne County, West Virginia, 1976-77.

Month	Plant Detritus (%)	Diatoms (%)	Filamentous Algae (%)	Mineral (%)
July	66.7	15.3	4.1	13.9
Aug.	68.7	12.9	4.3	14.1
Sept.	71.3	13.6	2.7	12.4
Oct.	72.6	13.2	2.1	12.1
Nov.	70.4	13.1	2.3	14.2
Dec.	63.7	11.8	2.9	21.6
Jan.	57.8	14.7	3.7	23.8
Feb.	59.7	19.3	2.8	18.2
Mar.	63.2	21.2	2.9	12.7
Apr.	63.5	23.5	1.2	11.8
May	59.8	29.9	0.8	9.5
Mean	65.3	17.1	2.7	14.9

adhesive layer present. Chorionic sculpturing was evident but the specific type was not determined.

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